Fabrication of single crystal diamond membranes using ion implantation and lift-off: Investigating the influence of defects in membrane production.

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1. Introduction

Single-crystal diamond (SCD) membranes with sub-micron thicknesses could provide an excellent platform for a variety of quantum and photonic technologies,[1] due to their potential to unleash the exploitable properties of point defects such as the negatively charged nitrogen vacancy NV^- centre. SCD membranes which satisfy the single mode condition in the vertical direction are important for the fabrication of optical waveguides and cavities,[2] and have previously been shown to significantly enhance the zero-phonon line emission efficiency of the NV^- centre.[3] However, reproducible and scalable fabrication of such membranes remains a challenge.

One method commonly used for fabricating SCD membranes is ion-implantation to produce a heavily damaged sub-surface layer, annealing (to convert the layer into "graphitic" material) and electrochemical etching[4] to facilitate the lift-off of a thin membrane.[5] However, the influence of the starting substrate material properties on the resultant membranes has not been thoroughly investigated. It has been shown that during the electrochemical etching the etch can become "pinned" in diamonds grown by chemical vapour deposition (CVD) and considerably increase the etching time.[6]

In this work, SCD membranes have been fabricated using 2 MeV carbon ion implantation, annealing and lift-off of horizontally (growth direction normal to largest face of membrane) and vertically cut (growth direction in the plane of the membrane) CVD diamond plates and high pressure high temperature growth diamond. The samples were characterized throughout the process using techniques that included cross-polar imaging, white-light interferometry, Raman and photoluminescence spectroscopy/microscopy. The pinning observed during electrochemical etching is investigated, and the properties of the resultant membranes investigated.

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3. References

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